Subsystem Testing Review

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February 2015
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If offered a seat on a rocket ship, don't ask what seat. Just get on.

— Christa McAuliffe
Mission Overview

Our mission is to collect readings of cosmic radiation using Geiger tubes during a rocket’s flight.

Our mission was born from a desire to learn and work as a team to achieve a common goal. We hope our experiment to detect cosmic rays will enhance our education, inspire our fellow students, spark interest in the STEM disciplines, and ignite a passion for space exploration.

In addition, Oregon State University RockSat C team will utilize our data to enhance their Tardigrades research.
The basic operation of the payload is extremely straightforward.

- **t = 0 min**
  - G switch activates
  - Begin data collection

- **t = 20 min**
  - Timed shutdown
  - End data collection

- **Altitude = 0 m**
  - Splashdown
Theory of Operation

- We have an array of 6 geiger tubes operating at 500v
- Output pulses from each tube are collected by the logic board and trigger an interrupt & record event on our arduino.
- The arduino periodically stores data on our SD card.

A word document extensively covering our theory of operations is included as an appendix to this presentation.
Final Design Description

“It’s not hard, it’s just rocket science!”
-LBCC Space Exploration Team
The Remove before Flight plug allows power from two 9v batteries to reach a G-switch, which on launch will supply power to the logic board.

The logic board supplies 9v power to the arduino, and each of the 6 Geiger boards.

Each of the Geiger boards connects separately to the logic board, returning a 5v signal line.

After a predetermined amount of time, the arduino uses a solid state relay to disconnect power from the logic board, shutting down the entire system.
Changes from CDR

Mechanical:
No significant changes

Electrical:
Geiger board layout has changed slightly. Schematic is the same but the layout traces have been shortened in our second rev of the board.

Programming:
No significant changes
2 Mechanical Design Elements

Full Design in Canister

Components

OSU Payload

LBCC Payload

Canister
Mechanical Design Elements

Full LBCC Payload Outside of Canister

Dimensions

- Outside diameter of Geiger boards: 245.056 mm
- Diameter of Disks: 235.712mm
- Radius of cut-outs on Disks: 16.891mm
- Total height: 135.683mm
Mechanical Design Elements

Layer 1 Front

- 9V Batteries
- Logic Board
- Arduino Uno
Mechanical Design Elements

Layer 2 Isometric

- Geiger Boards
- Geiger Tubes
- Geiger Board Slots
## Detailed Mass Budget

<table>
<thead>
<tr>
<th>Components</th>
<th>OSU Qty</th>
<th>LBCC Qty</th>
<th>Individual Weight</th>
<th>Total Weight</th>
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<tr>
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<td>0</td>
<td>1</td>
<td>45 grams</td>
<td>45</td>
</tr>
<tr>
<td>Arduino Mega</td>
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<td>0</td>
<td>45 grams</td>
<td>45</td>
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<tr>
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<td>0</td>
<td>39.6 grams</td>
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<tr>
<td>9V Battery w/ mounts</td>
<td>2</td>
<td>4</td>
<td>84.86 grams</td>
<td>509.16</td>
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<tr>
<td>Makrolon Plate</td>
<td>2</td>
<td>3</td>
<td>300 grams</td>
<td>1500</td>
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<tr>
<td>Micro SD Card Shield</td>
<td>1</td>
<td>1</td>
<td>5 grams</td>
<td>10</td>
</tr>
<tr>
<td>USB Microscope Camera</td>
<td>3</td>
<td>0</td>
<td>612 grams</td>
<td>1836</td>
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<tr>
<td>Geiger boards</td>
<td>0</td>
<td>6</td>
<td>47 grams</td>
<td>282</td>
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<tr>
<td>Logic board</td>
<td>0</td>
<td>1</td>
<td>100 grams</td>
<td>100</td>
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<tr>
<td>Geiger Tube</td>
<td>0</td>
<td>6</td>
<td>0.8 grams</td>
<td>4.8</td>
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<tr>
<td>Tube Mounting</td>
<td>0</td>
<td>6</td>
<td>180 grams</td>
<td>1080</td>
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<tr>
<td>Canister</td>
<td>0.5</td>
<td>0.5</td>
<td>3356.6 grams</td>
<td>3356.6</td>
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<tr>
<td>G-Switch</td>
<td>1</td>
<td>1</td>
<td>5 grams</td>
<td>10</td>
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</table>

**Total Weight:**

|                      | 4378.92 Grams | 4439.54 Grams |

**Combined Total Weight:**

|                      | 8818.46 Grams | 19.44 Pounds  |

**Under:**

|                      | 253.39 Grams  | .56 Pounds    |
Hazardous Mechanical Items

There are no moving parts or hazardous mechanical components in our experiment.

We are using CAD software to predict physical stress points and designing appropriate standoffs and supports based on overestimating expected forces during the flight.
Final Electrical Design

“It’s not hard, it’s just rocket science!”
-LBCC Space Exploration Team
Electrical Diagram

9v

G-Switch

Relay

Arduino Uno

SD-Card

Latch

6 Input NAND

5v

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V

Power Card Pulse shaping
9v-525V
Each Geiger tube has its own board with voltage regulation and pulse shaping. This allows us to replace any malfunctioning Geiger tube with very little effort. It also means a problem with any single tube will not affect the others.
### LBCC RockSat-C - Power Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Nominal Voltage (V)</th>
<th>Max Current (mA)</th>
<th>Start Time (min)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>mAh</th>
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</thead>
<tbody>
<tr>
<td>Arduino Uno</td>
<td>9</td>
<td>50</td>
<td>0</td>
<td>15</td>
<td>0.45</td>
<td>12.50</td>
</tr>
<tr>
<td>Logic Board</td>
<td>9</td>
<td>360</td>
<td>0</td>
<td>15</td>
<td>3.24</td>
<td>90.00</td>
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<tr>
<td>Gieger Board X 6</td>
<td>9</td>
<td>640</td>
<td>0</td>
<td>15</td>
<td>5.76</td>
<td>160.00</td>
</tr>
<tr>
<td>SD Card Unit</td>
<td>9</td>
<td>50</td>
<td>0</td>
<td>15</td>
<td>0.45</td>
<td>12.50</td>
</tr>
</tbody>
</table>

#### Total

- **Total Power Capacity**: 1,200.00
- **Over/Under**: 925.00
- **# of Flights Margin**: 4.4
Hazardous Electrical Items

- The HV transformer produces an operating voltage of ~500V, we will allow time for discharge before disassembly.
- Our entire PCB assembly will be conformal coated to minimize shorting and fire risks.
- To minimize overcurrent damage and risks we have added a fuse to our PCB assembly.
- "idiot" diodes in series with the geiger boards to minimize the chance accidental reverse polarity.
- There is a shutdown circuit on the logic board which will cut power after 15mins significantly reducing the chance of damage to our circuit/data after splashdown.
- The lithium batteries used will generate heat through operation posing a small fire risk, our choice of two batteries will reduce the current and heat generated.
- According to the Safety Data Sheet our two 9V batteries are considered Hazardous Materials.

Energizer Designations:

<table>
<thead>
<tr>
<th>Name</th>
<th>Designation</th>
<th>Voltage</th>
<th>ANSI Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energizer Advanced Lithium</td>
<td>LA522</td>
<td>9V</td>
<td>ANSI-1604LC</td>
</tr>
</tbody>
</table>
Final Software Design

“It’s not hard, it’s just rocket science!”
-LBCC Space Exploration Team
Software Design Elements

Our software will record the status of all geiger tubes, every time any two tubes experience a change in voltage.

The incoming data will be stored in a small buffer, and written in batches to an SD card. By using a buffer, we can record new events at the same time as we write to the SD card, so we shouldn’t miss any data.

We can match the timestamp to altitude data gathered on the ground, to graph and visualize trends in the data.

Sample data output will look something like this:

13546459 00100100

This indicates a coincidence event occurred between tubes A and D, after 13.56 seconds of flight.
**Software Design Elements**

**Pseudocode:**

**Setup():**
- Create a new file on the SD card.
- Initialize buffers A and B to temporarily hold data.
- Initialize interrupt(s)

**Loop():**
- Until splashdown, wait for an interrupt.
  - Append timestamp and all tube states to buffer A
  - If buffer A is full:
    - Swap to buffer B
    - Write buffer A to SD card.

**On splashdown:**
- Stop new readings, write current buffer to SD card, and trigger solid state relay to cut power.
De-Scopes and Off Ramps

“It’s not hard, it’s just rocket science!”
-LBCC Space Exploration Team
Reduce the number of Geiger Müller counters from 6 → 3.

Benefits:
• Reduces complexity
• Reduces the weight
• Allows us to complete our mission requirement of comparing single hits to coincidence hits during flight.

Downsides:
• Fewer geiger tubes available for redundancy in case of failures
• Reduces angle between tubes (increases space between neighboring tubes) decreasing our number of measured particle hits.
Off-Ramps - Mechanical, Electrical, Software

**Electrical**

Eliminate the timed shutdown of system

Benefits:
- Reduces complexity
- Eliminates the possibility of early shutdown

Downsides:
- Possibility of corrupted data through uncontrolled shutdown

**Software**

Remove formatting error check for the SD card

Benefits:
- Reduces complexity of software

Downsides:
- Possibility of incorrectly formated SD card that would not store data
The vehicle explodes, literally explodes, off the pad. The simulator shakes you a little bit, but the actual liftoff shakes your entire body and soul.

Manufactured or Purchased:
- Seven Geiger tubes
- Eight complete (sans tube) Geiger boards
- Two complete logic boards
- Two Arduino Unos
- One experimental test Canister
- Eight nine volt batteries
- Four SD cards
- Two Micro SD Card Shields

Not Manufactured/ Purchased:
- Geiger tube mounting
- Makrolon Plates
A mock up canister is being made by our Welding Department.

We still need the 3D printed boxes for our Geiger tubes, and the Makrolon plates.

Stand off’s and mounting hardware will need to be purchased.

These are available at all good industrial suppliers.
Electrical Elements

We currently have:

• 3 PCB’s and associated electrical components for 8 complete Geiger boards.
  – 1 fully assembled, 2 yet to be soldered.
• 4 PCB’s and associated electrical components for 2 complete logic boards.
  – Waiting for shipping for the last few components, but will arrive early this week.
• 8 of our final choice of 9v batteries.

We still need to purchase:

• 6 more Geiger board PCB’s, using our newly tested rev 2 design.
• Connecting wires between the logic board, and each of the Geiger boards.
Software Elements

Our current software has been tested and can do the following:

- Detect real-world voltage changes using an interrupt, on multiple pins.
- Store status of important pins on a pair of buffers.
- When buffer is full, swaps buffers and writes inactive buffer to an existing file on the SD card.
- Continues recording new events while writing to the SD card.

We still need to write code to:

- Shut down when splashdown occurs, based on elapsed time after g-switch activates.
- Create a new, timestamped file on SD card each time the arduino starts up.
- Solve any bugs we discover between now and launch.

The software is being tested on an Arduino Uno with an attached SD card shield. When we assemble the logic board, we will need to continue testing to ensure the software works with the new pin layouts and SD socket.
Back Up Components

Currently on hand
- One backup Geiger tube.
- Full set of extra electrical components.
- Several extra batteries.

Will have as completed
- One extra Geiger board.
- One fully functional Geiger tube with Geiger board set-up.
- Full backup logic board with microcontroller, SD card etc.
Subsystem Testing Results

Space is hard - but worth it. We will persevere and move forward together.

— Richard Branson
Our payload has 4 subsystems:
- Power
- Electrical
- Software
- Mechanical
The 1200mAh sourced from a pair of 9V Lithium Manganese Oxide (LMO) Energizer Batteries will be sufficient to power the entire experiment for over an hour. In addition: we have the mass and volume available to go up to 4x 9V or even an alternative power source such as a rechargeable high capacity battery pack if necessary.

Based on battery data sheets, our testing so far and conservative estimates we will have enough onboard power for 4 flights.

In the off chance our batteries completely run out of power, we have planned a “Death with Dignity” shut down that will turn the entire system off after fifteen minutes from launch.
Electrical Subsystem Overview

The electrical system includes 3 important groups of components:
- 6 individual Geiger boards.
- A logic board to transfer signal and power between the batteries, Geiger boards, and arduino.
- Two 9v batteries for power.

We have designed, assembled and tested two versions of the Geiger board, which are currently successfully detecting radiation and returning a signal via the output connection.

We have designed and received the logic board, but have not assembled or tested it yet. Some of the components are still in the mail, but we expect to begin assembly and testing over the next week.

We have sourced and ordered our 9v batteries based on our power budget.
Electrical Subsystem Testing

Our goal while testing is to identify problems and resolve unanswered questions:

• What is the expected power consumption of the geiger board?
• Does the circuit detect coincidence events as expected?
• How many counts per second to saturate our detection capability?
• Are the circuit interconnects adequate to resist vibration?
• Will a canister heater and/or insulation be required for electronics to withstand the harsh environment?
Early tests revealed a flaw in our prototype Geiger board. The high voltage oscillator was not sufficiently isolated from the detection circuit, which was causing false positive readings. Our solution was to reorganize the layout, moving the oscillator to reduce interference.

After printing a replacement PCB, we successfully tested the new version of the Geiger board. Our latest Geiger board is now responding properly to a radioactive source when compared against an off-the-shelf radiation detector.
Software Subsystem Overview

Our current software has been tested and can do the following:

• Detect real-world voltage changes using an interrupt, on multiple pins.
• Store status of important pins on a pair of buffers.
• When buffer is full, swaps buffers and writes inactive buffer to an existing file on the SD card.
• Continues recording new events while writing to the SD card.

We still need to write code to:

• Shut down when splashdown occurs, based on elapsed time after g-switch activates.
• Create a new, timestamped file on SD card each time the arduino starts up.
• Solve any bugs we discover between now and launch.

The software is being tested on an Arduino Uno with an attached SD card shield. When we assemble the logic board, we will need to continue testing to ensure the software works with the new pin layouts and SD socket.
Software testing involves simulating particle events using several function generators.

The function generators create 5v electrical signals of the same duration we anticipate our Geiger boards will produce.

By using several function generators together, we can control, detect, and record the times when these signals occur simultaneously.

This allows us to test our software by feeding it predictable and known values.
Software Subsystem Testing

These tests showed several of our systems are working properly, such as toggling between buffers, listening for the interrupt, and recording the state of each tube.

They also revealed some of our time limits. For example it takes about 3 μs to store an event in the buffer, and the entire buffer was written to our current SD card in about 500 ms.

We believe we can significantly reduce the time needed to write to the SD card, and have begun exploring why it’s taking so long. Hint: not all SD cards are created equal!
Mechanical Subsystem Testing

- Thus far we have tested the fitting of our project within a Canister through solid works.
- We have also tested the equilibrium of our canister.
- We have kept a weight management chart to help stay within our allowed guideline parameters.

### Mass properties of final design

- **Configuration:** Default
- **Coordinate system:** -- default --

**Mass** = 4940.0702 grams

**Volume** = 2975252.8881 cubic millimeters

**Surface area** = 2080.3315 square inches

**Center of mass:** (inches)
- \( X = -0.0758 \)
- \( Y = 0.0963 \)
- \( Z = 4.7320 \)

**Principal axes of inertia and principal moments of inertia:** (grams * square inches)

Taken at the center of mass:
- \( I_x = (-0.0150, 0.0059, 0.9999) \)
- \( I_y = (0.9918, 0.1272, 0.0141) \)
- \( I_z = (-0.1271, 0.9919, -0.0078) \)

Taken at the center of mass and aligned with the output coordinate system:
- \( L_{xx} = 106316.4002 \)
- \( L_{xy} = 61.2054 \)
- \( L_{xz} = -106812.7759 \)
- \( L_{yx} = 106315.0473 \)
- \( L_{yy} = 106411.7759 \)
- \( L_{yz} = -105770.4249 \)
- \( L_{zx} = -457.4543 \)
- \( L_{zy} = 184.7981 \)
- \( L_{zz} = 75770.4249 \)

**Moments of inertia:** (grams * square inches)

Taken at the output coordinate system:
- \( I_{xx} = 216977.7655 \)
- \( I_{xy} = 25.1457 \)
- \( I_{xz} = 2228.5045 \)
- \( I_{yx} = 217456.6411 \)
- \( I_{yy} = 2436.9989 \)
- \( I_{yz} = 2436.9989 \)
- \( I_{zx} = 2436.9989 \)
- \( I_{zz} = 75844.6371 \)
Mechanical Subsystem Overview

- CG within 1”x1”x1” envelope
- Some empty volume and weight budget left for balancing
Mechanical Subsystem Overview

Final Design
First Design from CDR
Plan for Full System Testing

We are at a point in history where a proper attention to space, and especially near space, may be absolutely crucial in bringing the world together.

- Margaret Mead
Plan for Subsystem Integration

After testing the software, Geiger boards, and logic board separately, we will begin combining pieces and continue testing them together.

First, we plan to test our Geiger boards and logic board together, running the software and watching the results as we apply a source of gamma radiation. We hope to see all of these pieces working together, creating a small number of coincidence events.

Moreover, to determine if a coincidence is occurring, we will use a function generator to send a pulse through the logic board. This will confirm the components of the logic board are at peak functionality and will be dependable for detecting incoming data.

Next, we will make sure the system physically integrates with the canister and meets all of the requirements for weight and center of mass.

Testing Roadmap:
- Arduino Uno and Logic Board
- Software
- Function Generator
- Full system integrating into mock canister.
You could see the flames and the outer skin of the spacecraft glowing; and burning, baseball-size chunks flying off behind us. It was an eerie feeling, like being a gnat inside a blowtorch flame.

— Bill Anders, regards lift-off of the Saturn V, undated quotation credited by the International Space Hall of Fame.
We have lost a few members Sarah, Aaron, Amos, who was the head of our hardware team and Nick who was the head of our BoM and mechanics integration.

John-Paul Molden has taken over the hardware team, and Ariel Stroh is now the head of BoM and mechanics integration. We also have two great new additions Steven Blench & Jairo Montoya.

Steven is now working closely with Ariel about mechanical design and SolidWorks. Jairo has been a wonderful help with assembly and soldering.

Picture of Jairo coming soon!
## Team Contact Matrix

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Phone</th>
<th>US Person</th>
<th>Name</th>
<th>Email</th>
<th>Phone</th>
<th>US Person</th>
</tr>
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<tbody>
<tr>
<td>Hazel Betz</td>
<td><a href="mailto:hazel.betz.5652@mail.linnbenton.edu">hazel.betz.5652@mail.linnbenton.edu</a></td>
<td>541-908-1487</td>
<td>Y</td>
<td>Levi Willmeth</td>
<td><a href="mailto:lo9key@gmail.com">lo9key@gmail.com</a></td>
<td>541-708-2012</td>
<td>Y</td>
</tr>
<tr>
<td>Steven Blench</td>
<td><a href="mailto:steven.blench.5087@mail.linnbenton.edu">steven.blench.5087@mail.linnbenton.edu</a></td>
<td>541-409-7278</td>
<td>Y</td>
<td>Amelia Beckwith</td>
<td><a href="mailto:beckwith.a@gmail.com">beckwith.a@gmail.com</a></td>
<td>907-957-5351</td>
<td>Y</td>
</tr>
<tr>
<td>Ikaika McKgeague-McFadden</td>
<td><a href="mailto:mc.ikaika@gmail.com">mc.ikaika@gmail.com</a></td>
<td>541-231-3835</td>
<td>Y</td>
<td>Rong Yu</td>
<td><a href="mailto:rongwingyu@gmail.com">rongwingyu@gmail.com</a></td>
<td>N/A</td>
<td>Y</td>
</tr>
<tr>
<td>Ariel Stroh</td>
<td><a href="mailto:bassoon09@gmail.com">bassoon09@gmail.com</a></td>
<td>541-415-1040</td>
<td>Y</td>
<td>Alexis Shanice Hundley-Kennaday</td>
<td><a href="mailto:hundleya@onid.oregonstate.edu">hundleya@onid.oregonstate.edu</a></td>
<td>541-817-2995</td>
<td>Y</td>
</tr>
<tr>
<td>John-Paul Molden</td>
<td><a href="mailto:john.paul.molden@gmail.com">john.paul.molden@gmail.com</a></td>
<td>541-248-0612</td>
<td>Y</td>
<td>Sophia Xin Zhang</td>
<td><a href="mailto:zhangso@onid.oregonstate.edu">zhangso@onid.oregonstate.edu</a></td>
<td>503-329-6208</td>
<td>Y</td>
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<tr>
<td>Brianna Sparks</td>
<td><a href="mailto:briannalsparks@gmail.com">briannalsparks@gmail.com</a></td>
<td>971-239-7910</td>
<td>Y</td>
<td>Cristina Martinez Galvez</td>
<td><a href="mailto:martc418@gmail.com">martc418@gmail.com</a></td>
<td>N/A</td>
<td>Y</td>
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<tr>
<td>Christina Pack</td>
<td><a href="mailto:chrissylee81@hotmail.com">chrissylee81@hotmail.com</a></td>
<td>541-974-6017</td>
<td>Y</td>
<td>Parker Swanson</td>
<td><a href="mailto:swansop@linnbenton.edu">swansop@linnbenton.edu</a></td>
<td>541-760-5473</td>
<td>Y</td>
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<td>Delphine Le Brun Colon</td>
<td><a href="mailto:delphine.lebrun.5989@mail.linnbenton.edu">delphine.lebrun.5989@mail.linnbenton.edu</a></td>
<td>347-458-3164</td>
<td>Y</td>
<td>Greg Mulder</td>
<td><a href="mailto:mulderg@linnbenton.edu">mulderg@linnbenton.edu</a></td>
<td>541-908-4025</td>
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<tr>
<td>Jairo Montoya</td>
<td><a href="mailto:jairomontoya40@gmail.com">jairomontoya40@gmail.com</a></td>
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## General Budget

### Expenditures

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<tr>
<th>Description</th>
<th>Cost</th>
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<tr>
<td>Indispensable Flight Cost</td>
<td>$12,000</td>
</tr>
<tr>
<td>LBCC Hardware Costs So Far</td>
<td>$1,655</td>
</tr>
<tr>
<td>LBCC Estimate of Remaining Cost</td>
<td>$800</td>
</tr>
<tr>
<td>OSU Hardware Costs So Far</td>
<td>$174</td>
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<tr>
<td>OSU Estimate of Remaining Cost</td>
<td>$1,800</td>
</tr>
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<td><strong>Estimated Total Cost of Flight</strong></td>
<td><strong>$16,455</strong></td>
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### Fundraising

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<th>Source</th>
<th>Amount</th>
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<tr>
<td>Support from OSGC</td>
<td>$8,000</td>
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<tr>
<td>Support from LBCC grant</td>
<td>$2,000</td>
</tr>
<tr>
<td>LBCC Go Fund Me Campaign</td>
<td>$845</td>
</tr>
<tr>
<td><strong>Funds Raised So Far</strong></td>
<td><strong>$10,505</strong></td>
</tr>
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</table>

- Ongoing Go-Fund Me Campaign
- Science Night Fundraiser Being Planned
- Cost Share Avenues Being Explored

Link to the team’s general Go Fund Me account:

http://www.gofundme.com/LBCCRockSatCteam
The Oregon Space Grant Consortium (OSGC) is supporting the team with an $8000 cost share donation with the requirement that the LBCC/OSU team will raise $16,000 in matching donations.

Not all donations need to be monetary. The team can also leverage the 2 to 1 cost share by gathering non-monetary donations and using their value towards the $16,000 amount.

If we raise over $16,000 we can negotiate further donations from the OSGC.

<table>
<thead>
<tr>
<th>Potential Cost Share To Date</th>
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<tbody>
<tr>
<td>Money Raised</td>
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<tr>
<td>Parker’s Hours Fall</td>
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<tr>
<td>Parker’s Hours Winter</td>
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<tr>
<td>Canister Cost Share</td>
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<td>LBCC Travel Cost Share</td>
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The team at the Evergreen Aviation & Space Museum
The team at the Evergreen Aviation & Space Museum
Schedule

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Qtr 3, 2014</th>
<th>Qtr 4, 2014</th>
<th>Qtr 1, 2015</th>
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<td>Critical Design</td>
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<td>Progress Update Teleconference</td>
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<td>Subsystem Assembly</td>
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<td>Subsystem Testing</td>
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<td>RockSat Payload Canisters sent to customers</td>
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<td>Full Mission Simulation Test</td>
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<td>Launch Readiness Review Presentations</td>
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<td>60</td>
<td>Travel to Wallops Flight Facility</td>
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<tr>
<td>61</td>
<td>Launch Prep &amp; Launch Day</td>
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Schedule - Winter Term

12/15/2014 -12/19/2014 - Winter break intensive build weekend:
   Assembly, prototyping, software testing, fundraising and marketing plans.
   Trip to the Evergreen Museum to learn more about the Van Allen experiment on Explorer I.

01/16/2015 - Flights Awarded
01/05/2015 - PCBs sent out to be printed (first week of term)
01/26/2015 - Canister infrastructure preliminary design
01/26/2015 - Progress Update Teleconference
02/16/2015 - Geiger board and Geiger tube tested and operational
   Logic board sent to be printed
02/23/2015 - Subsystem Testing Teleconference
03/02/2015 - Logic board assembled and tested
03/16/2015 - Progress Update Teleconference
03/16/2015 - Assembly of 7 geiger boards and a spare logic board

2-day intensive subsystem testings and preliminary integration of system onto internal structure of the mock canister over spring break

Term Goals
✓ Assembly, testings, complete canister infrastructure and integration.
Schedule - Spring/Summer Term

03/31/2015 - Canister infrastructure design done
03/31/2015 - Integrated Subsystem Teleconference
04/06/2015 - Integrated Subsystem Testing Review
04/13/2015 - Canisters Sent
04/20/2015 - LBCC/OSU System fully integrated
04/20/2015 - Progress Update Teleconference
05/04/2015 - Progress Update Teleconference
05/18/2015 - LBCC/OSU System fully tested for flight
05/11/2015 - Progress Update Telecon
05/18/2015 - Full Mission Simulation Review Teleconference
05/25/2015 - Progress Update Telecon
06/01/2015 - Progress Update Telecon
06/04/2015 - Preliminary Check-In Procedure Due
06/08/2015 - Launch Readiness Presentations
06/17/2015 - Travel to Wallops Flight Facility, Visual Inspection, Integration, and Presentation
06/25/2015 - Launch Day

Term Goals
✓ Send a Working Payload to Space!
We feel confident that we are on schedule. The payload’s electrical and software subsystem designs should be finished by spring break leaving only final assembly, mechanical integration into the canister, and full system testing.

We are waiting on our mock up canister to do shake tests and drop tests.

Our main scheduling concern is avoiding delays with the logic board. We are hoping our first testing results will allow us to keep the design of the logic board as is and proceed with our assembly and further testings.

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## Short term Schedule

- Assemble the 1st rev of the logic board
- Test the logic board and determine if a 2nd rev is needed
- Assemble the six tested geiger boards
- Begin testing individual geiger tube/geiger board systems
User Guide Compliance

“Houston, Tranquility Base here. The Eagle has landed.”
— Neil Armstrong
User Guide Compliance

Weight Compliance:
- The LBCC and OSU teams agreed to split the available space and weight equally between our experiments. Our combined weight between the two teams is 12.04 lbs. Including the canister our combined project weighs 19.44 lbs.

Center of Mass Compliance:
- Both teams have positioned the bulk of our experiments symmetrically around the center of the canister.
- As our mechanical testing progresses, we can add ballast to correct any drift in our mass caused by batteries, etc.
- The mockup canister will be an excellent resource while recentering our experiment using ballast.

High Voltage Compliance:
- We plan to use four 9v batteries in our project.
- Both teams will be using a G switch to activate our payloads.
Shared Can Logistics

We are sharing the canister with Oregon State University. OSU is taking the top half of the canister so they can add their extremophiles to the canister as late as possible.

Each project will have its own mounting plate for stability. LBCC will use the bottom mounting plate, and plan to use additional structural standoffs to support OSU’s bottom plate.

The two teams plan to collaborate when making the makrolon plates to mount the payloads in the canister. Investigation is being done into milling them at LBCC.

LBCC and OSU will continue to meet on a weekly basis utilizing Google hangouts, phone calls, and face to face meetings to collaborate on our projects and ensure they will fit together in the canister.
Conclusions

“Houston, Tranquility Base here. The Eagle has landed.”
— Neil Armstrong
Worries and Concerns

Electrical:
• Logic board testing may reveal problems requiring redesign and delaying completion of the system.
• The wires carrying 450-600Vdc to the Geiger tubes require attention as an unresolved concern.

Mechanical:
• Projected nearness to the canister weight budget (this can be mitigated by reducing the number of batteries.)
• Testing the proposed mounting for our geiger tubes and geiger boards.
• Determining a location to mill the Macron plates

Software:
• Thorough testing of the SD card is needed. If the card becomes corrupted or fails it could lose our data.

Budget:
• We need to raise approximately $6000 more to clear our hardware costs and finance the final payment on April 6th
Conclusions

Our goal is to design an experiment that will compare the performance of single count Geiger-Müller detectors and the performance of the coincidence gates collecting cosmic radiation during space flight.

We must design a payload capable of accurately recording high energy particles using multiple detection methods.

Construct payload capable of withstanding forces during launch and landing.

Test the payload, make sure it is fully compatible with all required specs.

Log results including time and altitude for analysis on the ground.

All aspects of our project have been cautiously planned out and our team is motivated to continue moving forward both with our own project and with OSU’s Water Bear project.

We welcome and value your feedback!